Journal of Construction in Developing Countries, 20(2), 81–95, 2015

Documentation Management Based on ISO for Construction Industries in Developing Countries

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Abstract: Improper document management (DM) can produce poor and erroneous documents and cause major issues, such as claims and disputes, in construction projects. Adopting a proper documentation management system (DMS) will enable the smooth completion of construction projects to overcome such issues. Quality management systems such as the International Standard Organisation (ISO) standards are designed with generic DM requirements. In developed countries, standard project management procedures and manuals are often used to guide such document requirements. However, construction industries in developing countries are still behind in this regard. Hence, this study aimed to explore the current DM requirements in the Sri Lankan construction industry and the reasons for poor DM and provides suggestions for overcoming these problems. A questionnaire was given to a sample of 30 large construction-contracting organisations operating in Sri Lanka, all of which had ISO certification. The findings revealed 40 DM-related construction activities and their needs and uses by the selected companies. Based on the suggestions given by respondents, this study proposes how to implement these activities and develop an appropriate DMS for the construction industry. This research will offer useful implications for developing countries that use similar standards and encounter similar DM issues.

Keywords: Documentation management, ISO, Quality management system, Construction industry, Contractors

INTRODUCTION

Documentation management (DM) enables consistent performance when carrying out processes, regardless of the time, location or person. Many researchers have emphasised the importance of producing adequate documentation in construction (for example, see Carmichael and Murray, 2006; Bjork, 2003; Roozbeh, 1995). Proper documentation of a construction project entails maintaining sufficient records that affect the history of the construction process (Levy, 2002). Document-based information is particularly important in dispute resolution proceedings (Roozbeh, 1995) for helping to avoid or resolve claims (Carmichael and Murray, 2006). In addition, conducting design reviews can reduce project costs and contract modifications (Furry, Hicks and Kirby, 1998). Proper documentation further assists in reaching agreements by defining the facts, roles and responsibilities of the work (Darwish, 2007) and can save time and money and increase the overall productivity of construction activities (Amor and Clift, 2007).

Current practices in construction encounter several problems due to improper or inadequate DM that result in poor documentation. Poor documents may cause a number of negative effects. Alwis (2005) found that errors, omissions and misinterpretations in contract documents are the main reasons for claims and disputes, while Kumaraswamy and Yogeswaran (2003) found that inadequate

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records are a main cause of delays in processing construction claims. Further, a large proportion of rework and non-conformance costs are due to deficiencies in documentation (Darwish, 2007; Love and Josephson, 2004). The quality and rigour of record keeping vary widely between different organisations. Many organisations have different procedures for keeping records. For many jobs, quality procedures for record keeping are not effectively implemented. Carmichael and Murray (2006) indicated that records are inconsistently kept in multiple forms and in various locations. The International Standard Organisation (ISO) aims to standardise documentation by stipulating various documentation requirements through quality management systems. However, as the forthcoming literature findings establish, there seems to be less understanding of how these requirements should be met by proper DM in the current practice. Hence, this research aims to identify current DM requirements in the Sri Lankan construction industry, with reasons for poor DM and suggestions for overcoming these limitations.

LITERATURE FINDINGS

According to Sutton (1996), documentation management system (DMS) can be defined as the process of overseeing an enterprise's official business transactions, decision-making records, and transitory documents of importance, which are represented in the document format. Hence, record keeping can be seen as a major part of DMS. The word "document" usually means an information carrier containing written or drawn information for a particular purpose (Matheu, 2005). According to Rezgui et al. (1998), the amount of data flowing through construction projects is exhausting, and it requires volumes of documentation. Proper documentation means ensuring that events are correctly and promptly recorded when important events are about to occur, are happening, or have happened, rather than creating endless reams of paper to fill endless filing cabinets (Levy, 2002). Hence, as Backblom, Bjork and Ruohtula (2003) stated, an effective DMS should reflect the culture of the organisation using it.

There are two types of DMS available, paper-based and IT-based DMSs. Instead of completely replacing a paper-based system, using a combination of an electronic and paper-based system is recommended for most industries (Amor and Clift, 2007). This hybrid system is used in the construction industry, as described by Bjork (2003). As stated by Bjork and Hjelt (2006), documents in the construction sector have not undergone major changes since the middle of the 20th century. However, the technology for producing, managing, duplicating, and distributing such documents has undergone many fundamental changes. Hence, Scott and Assadi (1999) noted that the recent changes in the way in which construction is undertaken clearly need to be recognised, and their impact on record keeping should be acknowledged.

Despite the need for a change in documentation management practices, some researchers have identified key issues in implementing DMS in the constructing industry. Rezgui (2001) explained that the problems encountered when implementing IT-enabled information systems in the construction industry are often due to high costs, particularly for SMEs, which could also be the case in developing countries. Bjork (2006) found that there are issues with user training aspects even in developed countries where electronic DMS are becoming

popular in the construction industry, and that these issues could be severe in developing countries. In fact, Zarebidaki, Nikakhtar and Wong (2012) state that it is costly to implement and purchase suitable DMS software and that it is difficult to work with them. Ali (2014) reveals another key issue in which ISO documentation leads to more paper work and end ups filling various forms. At the site level, Scott and Assadi (1999) found two categories of problems, problems with site procedures and problems with site staff and record keeping.

These problems can be overcome by gaining knowledge and understanding of proper DMS. As Backblom, Bjork and Ruohtula (2003) identified, improvements in the efficiency of a construction process will result from creating an awareness of the documentation value. Documentation should not be seen as a burden, but as a reflection of the way things are done (Li and Love, 2000). Staff must be trained because they have limited experience in procedure writing and reports (Li and Love, 2000; Darwish, 2007). The failure of proper documentation not only depends on the knowledge of the staff but also on the facilities given to the staff (Matheu, 2005). Reductions in the level of fees and the limited time made available to carry out the work contribute to this end (Darwish, 2007). Scott and Assadi (1999) suggested several ways to improve problems related to site procedures and staff. For example, better-organised methods with proper guidelines and inspections could be adopted to improve site procedures. These authors further suggested training and educating site staff, not only by giving adequate time but also by employing dedicated staff for record keeping.

Any improvement in documentation quality would lead to corresponding improvements in the construction process (Backblom, Bjork and Ruohtula, 2003; Lamprecht, 1993). Once developers fully understand the important value of documentation process quality, they would ensure that sufficient time and fees are available (Darwish, 2007). Matheu (2005) stated that contractors must be financially accountable for the overall documentation quality. Thus, it is commonly believed that quality assurance is the most preferable method of regulating DM requirements in the construction industry.

Many construction companies in the world are registered with the ISO (International Standards Organisation), and these companies adopt quality management systems (QMS) that comply with ISO standards. The importance of DM in ISO-QMS has been well recognised. In fact, an effective DMS is a basic requirement for any organisation seeking certification with ISO (Anne, 2000; Lamprecht, 1993). Adoption of ISO leads to changes in many areas of record keeping, increasing the number of records kept and leading to a greater consistency between construction parties (Scott and Assadi, 1999). According to Li and Love (2000), ISO directs an organisation to document what they do and then act as they have documented.

Although construction companies in developed countries are ahead because they have access to newer versions, such as ISO 9001:2008, in countries such as in Sri Lanka, ISO 9001:2000 (Senaratne and Jayarathna, 2012) is the most popular QMS used by contracting companies. In ISO 9001:2000, there are five broad categories, of which the first category, the QMS, stipulates documentation requirements. Wealleans (2005) identifies these document requirements using a pyramid analogy. Policy-level documents, such as Quality Manuals, are in the top layer, procedures are in the middle layer, and various forms are considered in the bottom layer.

Although the QMS stipulated by ISO states the importance of proper document treatment, they do not detail how to design and implement a suitable DMS to handle documentation and do not define its associated document processes (Hernad and Gaya, 2013). Hence, the standard is often experienced as being difficult to understand. Its flexibility and generic nature (Henry, 2000; Anne, 2000) have led many companies to create their own quality manuals. Accordingly, in some countries, the construction industry adopts a standard quality manual that corresponds with the quality standards. However, in developing countries, such as Sri Lanka, no formal attempts have been taken to do so (for example, see De Silva and Goonatilake, 2001; Pathirage, 2008), and not attempts have been made to fully understand the documentation requirements. Furthermore, a recent comprehensive literature review into IT-enabled DMS by Al Qady and Kandil (2013) shows that even some developed countries, such as Australia, are behind in IT-based DM implementations, while developing countries, such as Indonesia, are further behind. Hence, this study addresses this research problem by aiming to identify the current DM requirements in the Sri Lankan construction industry and to obtain reasons for poor DM and suggestions for overcoming these issues through a survey in Sri Lanka. The research method used in this study is explained in the next section.

RESEARCH METHOD

Initially, a pilot study was carried out with three industry experts to list the main document management activities by ISO categories of a Sri Lankan construction company while also referring to project management manuals published in other countries.

The survey method was identified as the most appropriate approach for this research and considered the need to obtain more quantitative data and apply the findings to only a country-specific population. Sampling is an important aspect of survey design. Thus, selecting the most appropriate sample was a critical issue for research. In this research, 34 contracting firms who operate within Colombo and its suburbs in Sri Lanka were selected. The specific selection criteria were large contractors with Class 1 grade (based on the national grading scheme), who have ISO 9001:2000 certifications. Hence, it was expected that the selected sample would be representative of large contractors in Sri Lanka. From the 34 contractors selected to distribute the questionnaires, thirty responded, indicating a very high response rate.

The questionnaires contained two main sections in addition to the background information and covering the following information: (1) the document management requirements and the DM activities, together with the extent by which they are met in the current practice and (2) reasons why the requirements are not fully met and suggestions for overcoming these limitations. Each parameter was assigned a score based on a one to five point Likert scale.

After data had been collected, they were analysed using appropriate statistical analyses. In this questionnaire analysis, the Relative Importance Index (RII) was used as a statistical analysis tool. RII is a statistical measure often used in construction research to determine the relative ranking of the factors. In addition, qualitative data were gathered to triangulate the analysed results.

$$\text{RII for groups} = \sum \frac{(W \times n)}{N \times A}$$

W = Weight given to each factor by respondents
A = Highest weight
n = Frequency of responses
N = Total number of respondents

Findings of this research are discussed in the subsequent section.

RESEARCH FINDINGS

The questionnaires were completed by a construction professional who was an expert in DMS activities for each company. The 30 respondents included eight project managers, four senior engineers, two civil engineers, six site engineers, eight quantity surveyors and two site representatives. Project managers and quantity surveyors were mainly targeted among these respondents because they conduct most document management activities in the construction industry.

DM Activities in Construction: Need vs Practice

The respondents were given the 40 DM activities related to construction and were asked to identify to what extent documents are needed for each identified activity to comply with ISO standards. To assess this, they were asked to rank the items on a five point Likert scale, with 5 being "strongly agree" to 1 being "strongly disagree". At the same time, they were questioned to identify to what extent this requirement is currently met (or practiced) by appropriate DM activities. To assess this, the respondents were asked to rank same activities on a five point Likert scale, with 5 being "always" and 1 being "not at all". The difference showed the gap between current DM practices and the overall requirements. Table 1 illustrates the results with RII values.

When comparing the results, documents related to communication, in particular, "to guide communication (including specimen letters) with client/ consultant" (0.94) and "to guide communication with other site personnel/ subcontractors" (0.93) were identified by the respondents as most required. Further, documents "to define the job descriptions, responsibilities and authority of key site personnel" (0.93) and "to describe the construction processes" (0.93) were highly required. Documents "to specify training to be provided for site personnel" (0.77) were identified as the least required. In terms of current practice, the need for documents "to describe the construction processes" (0.87) was met at the highest level, whereas the lowest need, at 0.77, was for documents "to specify training to be provided for site personnel". Therefore, the findings reveal that for some activities documents are highly required and also highly used, including documents "to describe the construction processes". However, looking at the gap (difference between the need and practice), documents for some activities were significantly required but less used, such as for "managing risks during the

construction processes" (ranked 1). Interestingly, the next highest gap, which was ranked 2, was "to specify how to prepare shop drawings". Overall, these differences show that current DMS practice does not fulfil the DMS requirements of the construction industry. The problems in current practice and possible solutions were queried from the respondents to fill this gap.

Table 1. DM Requirements and Current Usage

No.		Construction DM Activities	DM Needs	DM Practice	Gap	Rank
1	Management Responsibility	To define the job descriptions, responsibilities and authority of key site personnel	0.93	0.83	0.10	23
2		To review tender documents	0.89	0.83	0.06	33
3		To describe the construction processes	0.93	0.87	0.06	34
4		To guide the site planning and management of the site (storage area, cleanliness, security and other arrangements)	0.86	0.75	0.11	19
5		To specify what and how site records should be maintained	0.84	0.80	0.04	37
6		To specify methods used for scheduling and monitoring the progress of the works	0.88	0.76	0.12	15
7		To control drawings and design changes at site	0.92	0.85	0.07	28
8		To specify methods used for preparing project status reports (progress reports)	0.90	0.78	0.12	16
9		To describe the conduct of site personnel	0.83	0.70	0.13	13
10		To guide communication (including specimen letters) with client/ consultant	0.94	0.84	0.10	24
11		To guide communication with other site personnel/ subcontractors	0.93	0.81	0.12	17
12		To specify how to prepare shop drawing	0.88	0.71	0.17	2

(*continue on next page*)

Table 1: (*continued*)

No.		Construction DM Activities	DM Needs	DM Practice	Gap	Rank
13	Resource Management	To specify the qualification skills and experience required for the site personnel	0.87	0.71	0.16	7
14		To maintain properly the plant and equipment used for construction work	0.90	0.79	0.11	20
15		To specify the methods used for identifying and eliminating, potential resource problems	0.82	0.65	0.17	3
16		To specify training to be provided for site personnel	0.77	0.60	0.17	4
17		To specify work to be carried out during the defect liability period	0.79	0.63	0.16	8
18		To specify the procedures used for protection of the environment	0.90	0.79	0.11	21
19		To specify health and safety procedures at site level	0.87	0.81	0.06	35
20		To specify the methods used in cost controlling and monitoring	0.90	0.84	0.06	36
21		To specify the cost records of material, labour and equipment used for the works	0.90	0.80	0.10	25
22		To specify the time records of labour and equipment used for the works	0.85	0.78	0.07	29
23		For managing risks during the construction processes	0.89	0.64	0.25	1
24	Product Realisation	To evaluate the selected material suppliers	0.86	0.77	0.09	26
25		To evaluate the selected labour sub-contractors	0.83	0.76	0.07	30
26		To evaluate the performance of existing material suppliers	0.90	0.74	0.16	9
27		To evaluate the performance of existing labour subcontractors	0.90	0.76	0.14	12
28		To prepare documents/ orders for purchasing materials from suppliers	0.90	0.83	0.07	31
29		To prepare documents for purchasing services from subcontractors	0.91	0.80	0.11	22
30		To verify the quality of materials and supplier premises	0.90	0.73	0.17	5

(*continue on next page*)

Table 1: (*continued*)

No.		Construction DM Activities	DM Needs	DM Practice	Gap	Rank
31		To verify, store and maintain any materials or components supplied by the client	0.85	0.82	0.03	39
32		To positivity identify materials/ components used in the works (to avoid use of wrong materials/ components)	0.90	0.78	0.12	18
33		For the purpose of traceability (tracing back to the origin) of materials/ components used in the works (to identify the supplier)	0.88	0.72	0.16	10
34	Measurement, Analysis and Improvement	To specify inspections and tests to be carried out on the materials and the work (other than is given in specifications)	0.92	0.84	0.08	27
35		To specify frequency and procedures for calibration of measuring instruments and testing equipment	0.85	0.81	0.04	38
36		To specify the method used in identifying status of inspection and tests to be carried out on materials/components and the work	0.82	0.79	0.03	40
37		To specify the actions to be taken in case of defects or other non-conformances identified during inspection and testing	0.83	0.76	0.07	32
38		To specify the methods used for identifying root causes of any defects or non-conformances identified in materials/ components of the work	0.82	0.69	0.13	14
39		To specify the method used for handling and storage of materials components	0.87	0.70	0.17	6
40		To specify the methods used for identifying and eliminating potential problems with material purchasing	0.83	0.67	0.16	11

Problems and Solutions for DMS

To achieve this objective, quantitative and qualitative data were collected using closed and open questions in the questionnaire. It was observed that the major problems include a high initial cost to introduce DMS, a lack of trained staff for developing DMS, less interest in filling out forms, and difficulty in implementing documented procedures at the site level. Table 2 offers the RII values.

Table 2. Problems in DMS

No.	Major Problems	RII	Rank
1	High initial cost to introduce DMS	0.55	4
2	Lack of trained staff to develop DMS	0.75	2
3	Less interest in filling forms	0.79	1
4	Difficult to implement documented procedures at site level	0.65	3
5	Others	0.35	5

Less interest in filling forms was ranked 1. In analysing the related qualitative data, the reasons for these gaps mentioned by the respondents included a shortage of staff, delays in receiving project information, incomplete project information or documentation details unknown. Next, the lack of trained staff was identified as a major problem. Respondents mentioned that staff were not familiar with computer-based DMS and were not encouraged to use them by their supervisors. In terms of difficulties at the site level, which were ranked 3, "reluctance to change" and "less awareness" were identified further. For high initial cost, the respondents also noted "less time availability" and "uncertain project outcomes". The specific problems discussed under others were related to staff and procedures, such as compliance with government regulations, loss of information, poor quality and maintenance issues.

Solutions to the above-identified problems were queried next based on findings from the literature. The results from the respondents are given in Table 3.

Table 3. Solution for the Problems in DMS

No.	Factor	RII	Rank
1	Suggestion relating to DMS procedures	0.75	2
2	Suggestion relating to site staff	0.72	3
3	Creating an awareness of the value of the documentation	0.78	1
4	Specify a certain amount of money for documentation system	0.55	4
5	Others	0.21	5

The results depict the importance of "creating an awareness of the value of the documentation", which received the highest RII. In addition, suggestions related to DMS procedures and site staff were important. To complement the above results, respondents were asked to detail their solutions using an open-ended question. The results are summarised in Table 4.

As Table 4 indicates, there were several suggestions identified in relation to procedures. Most of the respondents suggested operating DMS in a "mixed" environment of paper and electronic data rather than moving completely to IT-based DMS. Further, they suggested documenting key procedures, which should be linked with others, and using practicable, short and simple methods. Such a system should have mechanisms to obtain feedback from users and be updated periodically. These procedures should follow good practices adopted by experienced staff and guidelines and regulations stipulated by professional bodies and government bodies. Site-based quality plans and regular inspection

of site records were other suggestions offered. Additionally, some respondents mentioned a need to practice these standards with a basic productivity improvement system, such as the 5S systems.

Table 4. Solutions from Qualitative Analysis

Suggestions Relating to Procedures	**Suggestions Relating to Staff**	**Creating an Awareness of the Value of Documentation**	**Specify a Certain Amount for Documentation System**
Keep DMS in both paper based and IT based forms	Train and educate staff in IT based DM systems	Organise company level awareness programmes on DMS	Should not limit to a specific amount
Adopt documented procedures that are practical and inter-connected	Motivate staff by giving awards to best document manager	Provide opportunity for staff to participate in other awareness programmes	Allocate reasonable cost and time
Implement a system to get feedback	Employ a dedicated staff member for DM		Estimate the cost of DM for tendering
Follow good practices and relevant regulations	Create documentation coordination roles within project team		
Have a proper site-based quality plan with regular inspections for quality checks			
Implement 5S principle			

There were valuable suggestions mentioned by the respondents in relation to the staff as well. Most of the construction staff in each organisation was not familiar with computer-based DMS. Hence, there was a notable need to train and educate the entire staff in IT-based DMS processes, and this solution was suggested through workshops and seminars organised by national contractor associations. Some even suggested motivating staff by giving awards, such as the best documentation manager. Trained and dedicated staff is important for successful implementation of a DMS system. Thus, the majority suggested employing a dedicated staff member who could oversee document preparation, visible storage and the arrangement of staff according to the size of the project. This could be achieved by creating documentation coordination roles for other project staff.

In terms of creating awareness, organisational-based programmes, such as meetings, arranged workshops, project site visits and awareness programmes, were identified by the respondents. Other educational and awareness programmes conducted by ISO and by national and professional organisations were mentioned by some together, with the need for organisations to provide opportunities to attend these outside programmes. One respondent mentioned

that it would be ideal to organise large-scale activities, such as exhibitions, trade fairs and carnivals, monthly in various parts of the country to raise national awareness and promote shared solutions to good construction documentation.

In terms of cost allocation for DMS, most of the respondents' opinions were not to consider the specific upfront amount for DMS implementation because there would be long-term benefits, which would pay-off the initial high costs. However, to get started, it would be important to allocate a reasonable portion or sum of money and time. It was noted that the cost for the DMS scales according to the project scale, number of staff and places involved. Therefore, this time will be appreciable, e.g. creating one of the BOQ items in the preliminaries section for the DMS or allocating a percentage for DMS while preparing rate breakdowns for BOQ items.

Overall, when comparing these research results with the literature findings, it is noted that the problems identified through the literature review were further confirmed through the survey. It is interesting to see that contractors find "less interest in filling out forms" to be the biggest hurdle, which is consistent with Ali (2014). A "lack of trained staff" becomes the next issue, which is also frequently identified in the literature (for example see, Scott and Assadi, 1999; Bjork, 2006). Surprisingly, the contractors ranked the "high initial cost" after "difficulties at the site level" as a major problem because they believed the high cost would be paid off by the long-term benefits. These suggestions were consistent with the literature findings, mainly of Scott and Assadi (1999) and Backblom, Bjork and Ruohtula (2003). Figure 1 maps all key research findings in a summary form and offers a holistic view.

In the centre of Figure 1, the top 20 DM requirements for construction organisations are listed, as shown in the survey results. It begins from the first priority, which is the need to develop documents for managing risks, and shows the 19 other key DM requirements in the current industry in their priority order. These DM requirements could be addressed by the contractors in developing countries and refer to appropriate sections of the project management procedure manuals published for developed countries. On the left of Figure 1, the problems associated with not meeting these requirements are mapped, and, on the right, the suggestions on how to meet them are mapped. The next section offers conclusions and the key implications of these findings.

Rank	Document Management (DM) Needs in Construction
1	For managing risks during the construction processes
2	To specify how to prepare shop drawings
3	To specify the methods used for identifying and eliminating potential resource problems
4	To specify training to be provided for site personnel
5	To verify the quality of materials and supplier premises
6	To specify the method used for handling and storage of materials components
7	To specify the quantification skills and experience required for the site personnel
8	To specify work to be carried out during the defect liability period
9	To evaluate the performance of existing material suppliers
10	To specify for the purpose of traceability of materials/ components used in the works
11	To specify the methods used for identifying and eliminating potential problems with material purchasing
12	To evaluate the performance of existing labour subcontractors
13	To describe the conduct of site personnel
14	To specify the methods used for identifying root causes of any defects to non-conformances identified in materials/ components of the work.
15	To specify methods used for scheduling and monitoring the progress of the works
16	To specify methods used for preparing project status reports (progress reports)
17	To guide communication with other sire personnel/ subcontractors
18	To identify materials/ components used in the works (to avoid wrong materials/ components)
19	To guide the site planning and management of the site (storage area, cleanliness, security and other arrangements)
20	To maintain properly the plant and equipment used for construction work

Figure 1. Document Management in Construction Organisations: Needs, Problems, Solutions

CONCLUSIONS

The aim of this study was to identify current DM requirements in the Sri Lankan construction industry, including reasons for poor DM and suggestions for overcoming these obstacles. From a pilot study, we identified forty construction activities that needed to be in a DMS system that comply with ISO 9001:2000 quality management standards. To obtain answers, a questionnaire survey was conducted with a sample of 30 large contractors in Sri Lanka who have ISO certification. Using RII values, the overall requirements and usage of documents related to the 40 activities were ascertained.

The findings showed that there is a gap between the requirements and the document usage. This gap was high for areas such as risk management and training. Several major problems were identified, such as less interest in filling forms, lack of trained staff and several difficulties at the site level. In terms of overcoming these problems and addressing the current gap, significant suggestions related to procedures, staff, awareness programmes and allocation of resources were revealed through the survey results.

Overall, the findings of this study showed what documents were lacking for the adoption of ISO quality standards and offers some useful DMS tools for overcoming issues in the current DM practices of contractors (see Figure 1 for the holistic view of the key findings). Identified DM requirements could be addressed by the contractors in developing countries, also referring to appropriate sections of the project management procedures manuals published for developed countries. A proper DMS that suits current industry needs would be beneficial, as highlighted in this paper, and would help to overcome several issues that are currently encountered due to poor DM systems. More research in other developing countries would help to generalise these findings to a larger population. Further research can be undertaken for consultants' document practices and in case studies of new DMS implementations.

REFERENCES

Ali, M.C. (2014). Exploring the potential of integration Quality Assessment System in Construction (Qlassic) with ISO 9001 Quality Management System (QMS). *International Journal for Quality Research*, 8(1): 73–86.

Alwis, L. (2005). *Guidelines for Effective Construction Management*. Sri Lanka: Institute for construction training and development (ICTAD).

Al Qady, M. and Kandil, A. (2013). Document management in construction: Practices and opinions. *Journal of Construction Engineering Management*, 139(10): 06013002-1-7.

Amor, R. and Clift, M. (2007). *Document Models and Concurrent Engineering*. London and New York: Taylor and Francis.

Anne, L. (2000). ISO 9001 within the Swedish construction sector. *Journal of Construction Management and Economics*, 18(5): 509–518.

Backblom, M., Bjork, B.C. and Ruohtula, A. (2003). Use of document management systems: A case study of the Finnish construction industry. *Electronic Journal of Information Technology in Construction*, *Special Issue on eWork and eBusiness*, 8: 367–380.

Bjork, B.C. (2006). Electronic document management in temporary project organisations. *Online Information Review*, 30(6): 644–655.

———. (2003). Electronic document management in construction: Research issues and results. *Electronic Journal of Information Technology in Construction*, 8: 105–117.

Bjork, B.C. and Hjelt, M. (2006). Experiences of EDM usage in construction projects. *Electronic Journal of Information Technology in Construction*, 11: 113–117.

Carmichael, S. and Murray, M. (2006). Record keeping for contemporaneous delay analysis: A model for effective event management. *Construction Management and Economics*, 24(10): 1007–1018.

Darwish, M.I. (2007). Factors affecting design and documentation quality in construction industry. MSc diss. King Fahd University of Petroleum and Minerals.

De Silva, G.M.S. and Goonatillake, L. (2001). ISO 9000 certification: Impact on the output and activities of sample of Sri Lanka companies. In L.M.R. Calingo (ed.). *Third National Convention on Quality Competitiveness Through Quality Management*. Colombo, Sri Lanka, 21–22 November. Sri Lanka: Association for Quality, 141–146.

Furry, D.A., Hicks, D.K. and Kirby, J.G. (1998). Improvements design review management. *Journal of Construction Management and Economics,* 114(1): 69–82.

Henry, E. (2000). Quality management standardization in the French construction industry: Singularities and internationalization prospects. *Construction Management and Economics*, 18(6): 667–677.

Hernad, J.M.C. and Gaya, C.G. (2013). Methodology for implementing document management systems to support ISO 9001:2008 quality management systems. *Procedia Engineering*, 63: 29–35.

Love, P.E.D. and Josephson, P. (2004). Role of error recovery process in projects. *Journal of Management in Engineering*, 20(2): 70–79.

Kumaraswamy, M.M. and Yogeswaran, K. (2003). Substantiation and assessment of claims for extensions of time. *International Journal of Project Management*, 21(1): 27–38.

Lamprecht, J.L. (1993). *Implementing the ISO 9000 Series*. New York: Marcel Dekker, Inc.

Levy, S.M. (2002). *Project Management in Construction*. 4th Ed. New York: McGraw-Hill.

Li, H. and Love, P.E.D. (2000). Overcoming the problems associated with quality certification. *Construction Management and Economics*, 18(2): 139–149.

Matheu, N.F. (2005). Life cycle document management system for construction. PhD diss. Universitat Politecnica De Catalunya.

Pathirage, A. (2008). Country report: Sri Lanka. In D.S. Wijeyasekara (ed.). *The 14th Asia Constructs Conference*. Tokyo, Japan, 23–24 October. Sri Lanka: Institute for Construction Training and Development (ICTAD), 3–17.

Rezgui, Y. (2001). Review of information and the state of the art of knowledge management practices in the construction industry. *The Knowledge Engineering Review*, 16(3): 241–254.

Rezgui, Y., Cooper, G., Marir, F., Vakola, M. and Tracey, A. (1998). Advanced document management solutions for the construction industry: The CONDOR approach. In B. Bo-Christer and J. Adina (eds.). *Proceedings of the CIB working Commission, W78 Information Technology in Construction Conference*. Stockholm: Royal Institute of Technology, 373–383.

Roozbeh, K. (1995). Construction documentation in arbitration. *Journal of Construction Engineering and Management*, 121(2): 201–208.

Scott, S. and Assadi, S. (1999). A survey of the site records kept by construction supervisors. *Construction Management and Economics*, 17(3): 375–382.

Senaratne, S. and Jayarathna, T. (2012). Quality planning process of construction contractors: Case studies in Sri Lanka. *Journal of Construction in Developing Countries*, 17(1): 103–115.

Sutton, M.J.D. (1996). *Document Management for the Enterprise: Principles, Techniques and Applications*. New York: John Wiley and Sons.

Wealleans, D. (2005). *The Quality Audit for ISO 9001:2000: A Practical Guide*. Hampshire, UK: Gower Publishing Limited.

Zarebidaki, A., Nikakhtar, A. and Wong, K. (2012). Document management in construction for shorter project lead time using web-based software. *Proceedings: The International Conference on Sustainable Design, Engineering and Construction (ICSDEC) 2012*. Texas, 7–9 November.